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The Current State of the Natural Resource Potential of the Seaside Regions of Ukraine

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Abstract

This study examines the state of the natural resource potential of the coastal regions of Ukraine, related to Russian aggression against Ukraine. The cited studies show that Ukraine has developed several legislative and regulatory acts in the field of use of the natural marine environment and adjacent territories, which correspond to international and European legal acts. Grossly violating international law, Russia caused significant economic damage not only to the population of the annexed territories but also to the environment. According to the Ministry of Environment of Ukraine, more than 3,600 crimes against the environment were recorded. This is the pollution of sea waters, the destruction of nature-protected areas, flora and fauna unique to this region. Damages caused to the environment are preliminarily estimated at more than 60 billion US dollars. The research methodology is based on statistical analysis of expert assessments given in official open state sources and mass media. Analytical studies made it possible to establish certain types of biodiversity that will be difficult to reproduce, as well as to outline the magnitude of the main catastrophic consequences of Russian aggression not only for Ukraine but also for the entire civilized world. Based on the conducted research, the conclusions were made that the existing international legal acts do not fully ensure adequate protection and protection of the environment, which in turn necessitates the development and improvement of effective legal, economic and other mechanisms of responsibility for ecocide. At this stage of military aggression in Ukraine, issues of environmental monitoring and assessment of growing losses come to the fore.

Keywords

Coastal areas; Natural resource potential; Military aggression; Rating; Damages

Introduction

Marine resources contribute to human well-being by providing food security and creating jobs. Almost 90% of the volume of freight transportation of goods is carried out by sea transport, and approximately 50% of all international tourist trips. The ocean is valued at more than US$24 trillion, while the annual "gross marine product" is at least US$2.5 trillion, which according to the World Bank ranks seventh in the national GDP of the world economy (WWF, 2015). The economic activity of the coastal regions of the state largely depends on the ability to effectively use three natural ecosystems - terrestrial, coastal and marine. The UN Convention on the Law of the Sea (UNCLOS, 1997) is considered to be an important legal factor in the development of the system of using natural mineral resources in international practice. The Convention defines the rights and responsibilities of nations regarding the use of the oceans and seas, establishing principles of management for business, and environmental protection. This document introduced several provisions, including the establishment of maritime areas and their respective limits of exclusive economic zones (EEZ), jurisdiction on the continental shelf, deep-sea mining, and the regime for the protection. The implementation of UNCLOS influenced the evolution of the economic development of individual states (Balla, 2016). The European Union exercises collective jurisdiction over the largest exclusive economic maritime zone in the world, comprising more than 20 million km2. The EU maritime economy employs more than 3.6 million people, generating a gross added value of almost 500€ billion per year. The single market for fish products in the EU is one of the largest in the world (Balla, 2017). The economic independence of Ukraine, its sustainable development and its integration into the Euro-Atlantic political, legal and security space largely depend on the effectiveness of the implementation of the state's maritime policy within the framework of global and European legal acts regarding the use of the natural resource potential of the marine environment. The Black and Azov Seas, which wash the shores of Ukraine, belong to the Atlantic Ocean basin. These seas are of great economic importance as a promising region for the production of hydrocarbon raw materials, an area for fishing, an important transport highway, and a region of great recreational potential. According to expert assessments, the potential of the Azov and Black Seas within the economic zone of Ukraine can ensure an increase in the annual volume of commercial products produced from the aquatic biological resources of the seas by approximately 56 million US dollars. The impact of Russia's military aggression on the sea is complex and multi-vectored, because it not only shook security in this region, but also led to changes in shipping and water management, affected marine biological and hydrological research that Ukrainian scientists have been conducting for decades, and became a new environmental challenge. As a result of the pollution of the marine environment, the unbalanced use of natural resources, as well as the lack of a system of integrated management of the use of natural resources of the Azov and Black Seas, Ukraine lost (approximately) 50 million US dollars every year. Throughout the Russian aggression in Ukraine, a report has been published annually on the direct damage to the infrastructure, which amounted to 155 billion US dollars. Unfortunately, however, it lacks data on environmental damage (KSE, 2024). According to data from the Ukrainian government, 600 species of fauna and 750 species of flora were damaged or destroyed (Ecological, 2023). As of August 2024, due to Russia's armed aggression, damage to the environment of Ukraine amounted to more than 60 billion US dollars (Economic Truth, 2024). Currently, there

are several publications related to the impact of military aggression on certain types of natural resources: forest (Senchyn, 2022), soil (Dmytruk, 2022) and comprehensive studies analyzing the impact of Russian aggression on land, water, and biological resources (Strokal *et al*., 2023). Research on the impact of environmental change on people's health and their psychological state (Khrushch *et al*, 2023), and training of specialists to assess damage caused by military aggression (Makarenko *et al*., 2022; Otsinka, 2023) deserve special attention. Given that Ukraine is a maritime state, in our opinion, issues related to the impact of Russian aggression on the coastal regions, including the flora and fauna, deserve special research.

The purpose of this publication is to draw the attention of the global communities to the problem of protecting the unique natural environment of the coastal territories of Ukraine, certain species of flora and fauna that are suffering from Russian aggression and are on the verge of destruction. The achievement of the set goal is ensured by the concentration of a single document of statistical data on the damage caused by Russian aggression to the coastal regions. The practical significance of the publication lies in the awareness of the magnitude of damages caused to the environment of the coastal regions of Ukraine, the use of these data by national and international institutions for the development and improvement of legal, technical and economic mechanisms for the assessment of damages, their compensation and legal responsibility for their infliction.

Methodology

The methodology of these studies includes problem formulation, collection and analysis of geospatial information, processing of input information, interpretation of the obtained results and development of conclusions and proposals on this basis. The main issue of the study is the confirmation of facts regarding the impossibility of suspending the destruction of the natural resource potential of the environment by aggressive military actions using modern legal mechanisms. The research methodology is based on the analytical analysis of statistical data on the damage caused by Russian aggression to Ukraine, publicly available by mass media, government institutions, and individual publications for the period 3 from 2022 to August 2024. Processing incoming geospatial information allows us to determine not only the amount of damage in monetary terms but also to identify individual species of flora and fauna that will be practically impossible to reproduce. It should be noted that since Russia's aggression continues, the numerical values of the losses are not final, but constantly change in time. as well as on the territory. Thus, the reliability of the given data corresponds to the date of their determination.

Research of Natural Resource Potential of the Azov-Black Sea Basin of Ukraine

Natural resource potential of the Azov-Black Sea basin of Ukraine in the pre-war period

Ukraine has the largest length of sea coast among the countries of the Azov-Black Sea basin (2,759.2 kilometres) and more than 72 thousand square kilometres of the exclusively maritime economic zone. A significant part of the national gross domestic product is formed by five oblasts of Ukraine, which have access to the sea and occupy about 27 per cent of its territory. The majority of the population in this territory lives at

a distance of no more than 60 kilometres from the sea and is closely related to maritime activities (Morska, 2018). In the late 1990s, the realization of the importance of marine natural resources and the recognition of the actual and potential value of the marine environment as an economic resource led to increased competition for its management. Until 2014, Ukraine controlled 137,000 square kilometres of the seas. This territory is called an exclusive zone. And within these limits, it is Ukraine that has the right to explore and extract minerals (Figure 1.)

Figure 1: Map of Ukraine before full-scale aggression (Uk.wikipedia, 2024)

About 150 species of zooplankton organisms have been found within the economic zone of Ukraine. The macrophyte flora of the Ukrainian part of the Black Sea shelf includes about 270 species. The algal flora is dominated by red algae (about 140 species). Plant communities are widespread at a depth of 0 to 20 m, but the largest thickets of macrophytes are concentrated at a depth of 1 to 5 m (Okeanografniy, 2009). Aquatic biological resources of the sea are the most important for coastal regions, and fisheries play a significant role in providing the population with food. The ichthyofauna includes almost 200 species and subspecies, including occasional freshwater and marine fish known from isolated finds. The basis of the ichthyofauna is marine fish. The main commercial fish species in the Azov-Black Sea basin in recent decades are sprat and hamsa. In the Black Sea, the share of these species from the total catch of Ukraine is more than 98%. In the Sea of Azov, fishing is based on Lyulka, halibut, pylengas and zander. Over the past ten years, there has been a reduction in the catch of aquatic biological resources by almost 2.5 times (Morska, 2018). On the Ukrainian shelf, significant reserves of minerals have been explored, including up to 1751,3 billion m^3 of

natural gas and up to 409.8 million tons of crude oil, which is more than 40 per cent of Ukraine's total hydrocarbon reserves (Decree, 2024)[1]. At the same time, only 4 per cent of them were mined, while up to 70 per cent of explored reserves were extracted from coastal deposits. 4-5% of the subsoil of Ukrainian water areas has been explored. According to these data alone, about two trillion cubic meters of gas are already stored in the exclusive economic zone of Ukraine. Ukraine will use approximately that much in just 50 years. In 2013, Ukraine's foreign companies issued a permit for oil production in the Black Sea. The agreement provided for work until 2063 and investments in the amount of 4 billion US dollars (VoA, 2021). Ukrainian geologists note that Crimea is very rich in natural minerals. For example, from the total reserves of Ukraine, about 50% of flux limestone, 30% of iron ore and 25% of soda are stored in this territory. The peninsula is also rich in deposits of bromine and potassium salt. Favourable natural and climatic conditions make it possible to develop resorts and tourism in the coastal strip of the Black and Azov seas. The length of the sea coast of Ukraine is more than 2,700 km, of which 1,160 km are valuable beaches. Two main regions of concentration of natural recreational resources are distinguished here - Crimean and Azov-Black Sea. A valuable element of Ukraine's recreational potential is deposits of healing mud of marine origin. The presence of attractive and diverse landscapes, sources of mineral water and mud creates all the conditions for the formation of a highly developed industrial recreational and tourist complex.

Natural resource potential during the period of occupation

Due to annexation and Russian aggression, the area of the Black Sea and Azov Sea controlled by Ukraine decreased by three times (Figure 2).

According to government information, almost 3,600 Russian crimes against the environment were recorded during the full-scale invasion. The war caused losses worth 55 billion dollars to Ukraine. In addition, hundreds of thousands of square kilometres of land are potentially contaminated by mines and shells. The level of seawater pollution in certain water areas of the coastal strip exceeds the maximum permissible concentrations of oil products, phosphorus and phenols by an average of five times (Society, 2023). In addition, significant water areas of the territorial sea of Ukraine and coastal defence strips are filled with minefields of the aggressor country (Russia). The main effects of war on coastal and marine ecosystems include chemical and acoustic pollution, physical damage to natural habitats, and the decline of conservation activities. Military actions also hinder ecological monitoring. According to official data, compensation for losses of mineral resources in the Crimea, and on the Black Sea shelf alone amounts to about 50 billion dollars. Currently, Ukraine does not control the pumping of gas at the wells of the state company Chornomornaftogaz, which were seized by Russia. This is about two billion cubic meters of gas per year. Experts note that Russia conducts mining in a barbaric manner, and in 5-10 years these deposits may be flooded and will not be subject to further exploitation. Military actions significantly influenced and changed the system of management and control of overfishing. Changes

[1] Decree of the President of Ukraine (2024). On the decision of the National Security and Defense Council of Ukraine dated July 17, 2024 "On the Maritime Security Strategy of Ukraine" Document 468/2024, adopted on July 17, 2024.

in the intensity and location of fishing affect fish stocks. Analysis by FAO showed that Ukrainian marine fishing fleets were out of action during 2022, losing almost the entire annual catch of 13,000 tons of fish. The total losses of the fishing industry in 2022 amounted to 47 million US dollars, including 25.4 - fisheries and 21.6 - aquaculture (Society, 2023; State, 2023). To determine real military aggression on the ecology of the seas, estuaries and wetlands, special further research is needed. Significant areas of coastal and marine water areas were protected at 20 objects of national significance. Since February 2022, access to two nature conservation areas has been lost: the Black Sea Biosphere Reserve and National Nature Park "Biloberezhya Svyatoslav", located in the Kherson region. All nature reserves of Ukraine, which include marine water areas, and Biosphere Reserve "Askania-Nova" are under occupation, along with seven coastal national nature parks and one biosphere reserve. Some of these territories are located directly in the zone where hostilities are taking place or where the Russian military is stationed, such as the Kinburn Spit and Dzharylgach Island in the Black Sea. On the Kinburn spit, 131 fires were recorded during the year of full-scale invasion.

Figure 2: Map of Ukraine with occupied territories (Uk.wikipedia, 2024)

The 2022 fires were the largest in decades and affected more than 5,000 hectares, including steppe and coastal ecosystems and nesting sites for approximately 100 bird species. The construction of fortifications and trenches, and numerous explosions damage vegetation and ground cover. The territories of Ukraine with an area of 174,000 square meters are considered to be mined (Ukrinform, 2023). Satellite data indicate the construction by the occupiers of fortifications and military fortifications in the coastal zone of the Emerald Network, which includes territories and water areas where rare types

of settlements in Europe are preserved. In addition to the Emerald Network, there are other water areas and coastal areas that are important for the preservation of species and habitats that are rare not only for Ukraine but for the entire planet. These are, for example, which were created within the framework of the Ramsar Agreement (Convention, 1996). According to 2.9 million hectares of Ukrainian territories of the Emerald Network, 17 wetlands with an area of more than 600,000 hectares will be at risk due to war (not only in the coastal zone).Environmental protection objects were seriously affected by the Russians' detonation of the Kakhovskaya HPP, which took place. Several objects of the nature reserve fund were in the flood zone, in particular, the Nizhny Dnipro National Nature Park, The significant volumes of freshwater contaminated with fertilizers, fuel lubricants, and sewage entered the Black Sea. The analysis of satellite data allowed scientists to calculate that after the explosion of the Kakhovskaya HPP, polluted river waters reached the mouth of the Danube River, covering more than 7,300 km^2 of seawater. In Odesa Bay, scientists recorded a rapid desalination of water and a drop in salinity from 14 to 4 ppm, and in some coastal areas in certain periods — a very high concentration of nitrogen, may be a sign of water pollution by sewage. A sharp decrease in salinity led to the death of certain hydrophones (underwater inhabitants) — colonies of mussels, fry, and fish eggs — which may further affect changes in the entire coastal ecosystem. Due to the ingress of so much fresh polluted water, the seawater began to bloom due to the massive development of microalgae. The estimated damage to water resources is approximately 500 million dollars. This is without the damage to the nature reserve fund, soils, biodiversity, forest and other natural resources (Kakhovsky, 2023).

Discussion

National legal acts on the use of the natural resource potential of coastal areas

The legal basis for the use of the natural resource potential of the coastal territories of Ukraine should be based on the existing international and national legislative and regulatory framework. First of all, the national legal framework should be based on the UN Convention and, as a European country, on the Directives of the European Union on this issue. In 2005, the European Commission included in its strategic tasks the need for a comprehensive maritime policy. The concept of the European Union's Integrated Maritime Policy (IMP) became official in European policy in 2006 (EC, 2006). On October 10, 2007, the European Commission presented the well-known Blue Book study (EC, 2007). The Blue Paper laid the structure and cross-sectoral tools needed for an integrated EU maritime policy. EU "blue economy" sectors have a high potential for growth: blue energy, aquaculture, marine, coastal and cruise tourism, marine mineral resources, blue biotechnology, etc. The Blue Book is the main guide for the development of the maritime economy. Coastal areas play an important role in the European economy, as they are home to the EU population, a wide range of human activities (tourism, recreation, holiday housing, fishing and aquaculture) and most of the transport and communication infrastructure. Intensive development and significant concentration of the above-mentioned types of activities often pose threats to coastal ecosystems and natural resources. In this regard, the EU has developed the concept, which should be implemented as a tool for the integrated management of processes affecting the coastal zone to further address the interaction of land and sea to ensure sustainable development.

In 2002, the European Commission issued a Recommendation (EC, 2002) which established specific principles to be followed by EU member states to ensure. The central place in the marine research strategy belongs to the marine bases of all EU countries (Balla, 2017) and covers the full cycle from their initial observation to interpretation, processing and dissemination. Maritime (2018) defines the strategy and main directions for further development of Ukraine as a maritime state. It delimits the powers of the executive authorities on maritime activities; determines priorities for ensuring maritime safety; establishes legal mechanisms for the ownership rights of the Ukrainian people to the exclusive (marine) economic zone of Ukraine; harmonizes the principles of state maritime policy with the interests of the socio-economic development of coastal regions. Special attention is paid to activities in the coastal regions. First of all, this is the solution to issues related to maritime spatial planning and an integrated coastal management system related to the use, restoration and protection of the coastal zone of the Black and Azov Seas; the creation of a network of marine objects; water areas with regulated economic activity and the development of regional investment maps of the seaside regions in the directions "marine industry" - "recreational and tourist sphere" (Law of Ukraine, 1995)[2] defines that the marine areas externally adjacent to the territorial sea of Ukraine, including the areas around the islands belonging to it, constitute the exclusive (maritime) economic zone of Ukraine. In this zone, Ukraine can regarding the exploration, development, management and conservation of natural resources. (Law of Ukraine, 2019)[3] establishes the status and defines the legal regime of the adjacent zone of Ukraine, as well as the procedure for Ukraine to exercise its rights as a coastal state in this zone. By the UN Convention on the Law of the Sea. The Law of Ukraine on recognition of Ukraine as the legal successor of the Union of the SSR concerning participation in the Convention on Wetlands of International Importance[4], mainly as a Habitat for Waterfowl (Law of Ukraine, 1996)[5]. Marine (2021) noted that the growth of anthropogenic load on the Sea of Azov and the Black Sea caused their unsatisfactory ecological condition. The main goals of this strategy are, in particular, the introduction of monitoring of the Black Sea; establishing and rendering in nature the boundaries of seas, sea bays and estuaries and ensuring the regularization of the coastal protective strip of seas; creation of an information system for forecasting the movement of oil products on the surface; implementation of other measures; creation of a system of integrated management of nature use within the water protection zone of the seas, the coastal strip of the seas, territorial sea waters of Ukraine; improvement of economic mechanisms for regulating the use of natural resources, including the use of seas for shipping and hydropower purposes; improvement of the legal framework for the implementation of state policy in the sphere of protection and reproduction of the environment, development of fisheries. The findings of the study indicate the need to develop effective

[2] Law of Ukraine. On the Exclusive (Maritime) Economic Zone of Ukraine (Vedomosti Verkhovna Rada of Ukraine (VVR), 1995, No. 21, Article 152).

[3] Law of Ukraine. On the Adjacent Zone of Ukraine (Vedomosti Verkhovna Rada (VVR), 2019, No. 3, Article 20).

[4] Convention on Wetlands of International Importance especially as Waterfowl Habitat Ramsar, Iran, 2.2.1971 as amended by the Protocol of 3.12.1982 and the Amendments of 28.5.1987 Paris, 13 July 1994 Director, Office of International Standards and Legal Affairs United Nations Educational, Scientific and Cultural Organization (UNESCO).

[5] Law of Ukraine. On the participation of Ukraine in the Convention on Wetlands lands of international importance, mainly as a habitat for waterfowl (Vedomosti of the Verkhovna Rada of Ukraine (VVR), 1996, N 50, Article 279).

practical mechanisms to stop the destruction of the natural environment by aggressive military actions.

The conducted analytical review of the state of the natural resource potential of the coastal regions of Ukraine, and the compliance of national regulatory and legal documents with international and European jurisdiction allowed us to identify both general and local trends in the problem of environmental protection and protection as a result of military aggression. First of all, at the international level, legal documents that would ensure irreversible processes of urgent compensation for damage caused to the ecosystem are not sufficiently developed. To implement this provision, it is necessary to create both a legislative framework and separate specialized judicial instances and bodies to ensure the implementation of court decisions. On the specific example of Russian aggression against Ukraine, the destruction of 17 wetlands included in the international protection system was established, the irreparable loss of mussel colonies, fry of certain fish species in the Black Sea. Fires on the Kinbur Spit destroyed the nesting of more than 100 bird species. Studies have shown that the marine environment has a significant impact on the stability of the development of the economy of coastal regions. However, the aggression completely suspended fishing, tourism and shipping. Total losses are estimated at billions of dollars. Compensation for damage and restoration of ecosystems should be compensated by the aggressor, primarily at the expense of its assets located in other countries. It should be noted that the authors did not set the goal of developing special documents on environmental protection and conservation, but tried to prove to the international community the magnitude of the existing catastrophe, focusing attention on the need to develop appropriate mechanisms to prevent such phenomena in the future.

Conclusion

Due to Russian aggression, Ukraine is experiencing immense economic, human, and environmental losses that often cannot be recovered. One of these regions is the coastal south of Ukraine, where the aggressor uses the method of destroying not only industrial and social infrastructure but also causing unique nature reserves and biodiversity. The destruction of the Kakhovskaya Hydroelectric Power Plant, along with the devastation of the Nizhny Dnieper National Nature Park and the white coast of Svyatoslav National Nature Park, has severely impacted wetlands of international importance covering more than 600,000 hectares. Additionally, the occupiers have constructed fortifications and military installations in the coastal zone of Ukraine's Emerald Network. This network includes territories and water areas that are home to rare species of fauna and flora. In Europe, crimes against human civilization can be interpreted as ecocide, for which there should be legal responsibility at the international level. The national legal framework for the use and protection of the natural resource potential of the state's coastal territories within its borders is generally brought into line with the UN Charter. Convention on the Law of the Sea of 1982 and other world and European documents. It is necessary to carry out constant purposeful monitoring of the aggressor to improve measures of a legal, economic, social, educational, informational and organizational nature; aimed at protecting the natural environment, and ensuring environmental safety.

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Authors' Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with ICMJE criteria for authorship)

Contribution	*Author 1*	*Author 2*	*Author 3*	*Author 4*	*Author 5*
Conceived and designed the research or analysis	Yes	No	Yes	Yes	Yes
Collected the data	Yes	No	Yes	No	No
Contributed to data analysis & interpretation	Yes	Yes	No	Yes	No
Wrote the article/paper	Yes	Yes	Yes	Yes	Yes
Critical revision of the article/paper	Yes	Yes	Yes	Yes	Yes
Editing of the article/paper	Yes	Yes	Yes	Yes	Yes
Supervision	No	Yes	No	Yes	Yes
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Research involving human bodies or organs or tissues (Helsinki Declaration)
The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not a clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

Research involving animals (ARRIVE Checklist)
The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind animal. The contexts of animals were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of ARRIVE does not apply in cases of this study or written work.

Research on Indigenous Peoples and/or Traditional Knowledge
The author(s) solemnly declare(s) that this research has not involved Indigenous Peoples as participants or respondents. The contexts of Indigenous Peoples or Indigenous Knowledge were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or prior informed consent (PIC) of the respondents or Self-Declaration in this regard does not apply in cases of this study or written work.

Research involving Plants
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Research Involving Local Community Participants (Non-Indigenous) or Children
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